



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
20.01.2021 Bulletin 2021/03

(51) Int Cl.:
B63B 27/18 (2006.01) B63B 27/32 (2006.01)

(21) Application number: **20167326.6**

(22) Date of filing: **31.03.2020**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(72) Inventors:
• **HILGER, Klaus Baggesen**
2820 Gentofte (DK)
• **SAGUES, Guillem Blanco**
2820 Gentofte (DK)
• **WINDOLF, Mikkel Haugaard**
2820 Gentofte (DK)

(30) Priority: **19.07.2019 EP 19187278**

(74) Representative: **Gaunt, Thomas Derrick et al**
Lewis Silkin LLP
5 Chancery Lane
Clifford's Inn
London EC4A 1BL (GB)

(71) Applicant: **Ørsted Wind Power A/S**
7000 Fredericia (DK)

(54) **MARINE TRANSFER APPARATUS AND METHOD OF USING THE SAME**

(57) Marine transfer apparatus for transferring a body (7) between a vessel (6) subjected to waves and an offshore structure (10). The apparatus comprises a transfer cable (1) on which the body (7) can ascend and descend in use. A structure coupling (4) connects a first end of the transfer cable (1) to an attachment point (12) provided on the offshore structure. A vessel coupling (5) connects a second end of the transfer cable (1) to the

vessel (6). The transfer cable (1) comprises an elastically extendable region (3) for extending its length when taut between the structure (4) and vessel couplings (5) as the vessel moves in the waves (9). The vessel coupling (5) further comprises a reeling device (8) for reeling the transfer cable (1) between a taut state and a slack state when connected between the structure (4) and vessel couplings (5).

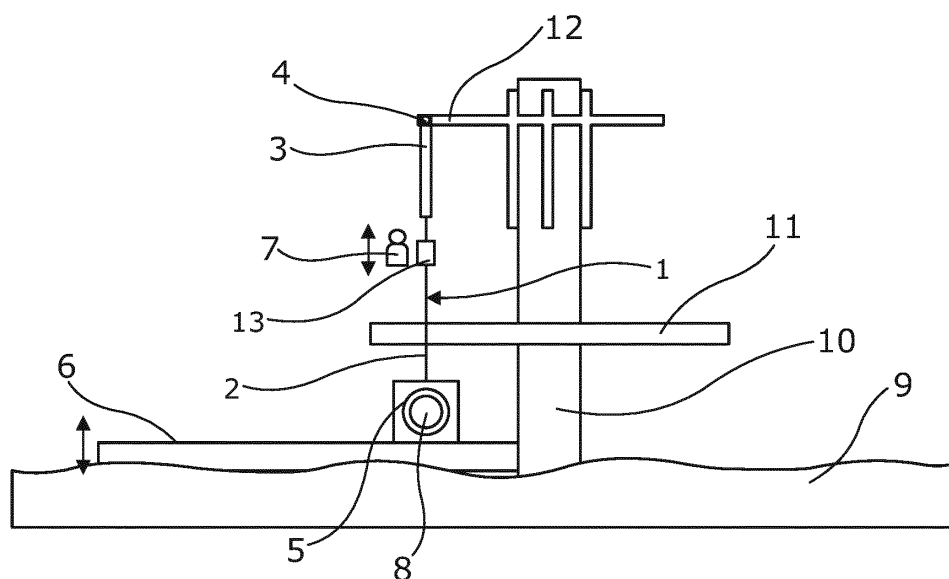


Fig. 1(c)

Description

[0001] The present invention concerns a marine transfer apparatus and method for transferring a body between a vessel and an offshore structure and, in particular, a marine transfer apparatus and method for use with a monopile offshore structure, such as a wind turbine generator having a monopile foundation.

[0002] Transferring a body, such as a person or an object, between a marine vessel, such as a boat, and a fixed offshore structure can be a challenging and hazardous process. Waves in the water, caused by wind or swell, act on the vessel, moving its position relative to the offshore structure. In particular, as waves pass through, movements of the vessel can be complex and difficult to predict because the vessel may be simultaneously subjected to both rotational motions, such as pitch, roll and yaw, as well as translational motions, such as heave, sway and surge. In some circumstances it may be possible to minimise motions such as roll, yaw, sway and surge by driving the vessel into an offshore structure's boat landing so that the vessel pushes onto the foundation. However, vertical motions are difficult to mitigate. Such vertical motions are especially hazardous because there is a risk that the person could get caught between the vessel and the structure when they are attempting to transition from the vessel onto, for example, a static ladder provided on the exterior of an offshore structure.

[0003] Various methods have been previously adopted to address the above issues. For example, helicopters can be used in some circumstances, either by landing on a platform on the structure itself or by a person rappelling down from the helicopter onto a platform. However, helicopters are expensive to operate and are only able to land on very large platforms, such as those provided on oil platforms. They are also not suitable in high winds or poor visibility, and these restrictions are even greater in situations where rappelling is necessary. Other solutions involve the use of motion compensated gangways between the vessel and a platform, although these are only feasible for use from larger ships, which consequently adds to the expense and complexity. Finally, various techniques involving the use of cranes and hoists from the offshore platform have also been proposed. In such systems, a cable may be hung down from the offshore platform, and the body may be hoisted from the platform using the cable. Distance control systems are typically used with such arrangements to control the winch or hoisting mechanism to compensate for movements of the vessel by tracking its movements using lasers or ultrasonic sensors. However, such winching or hoisting mechanisms are often complex and not sufficiently responsive to fully mitigate the effects of a vessel's movements.

[0004] The above problems are particularly exacerbated in the case of transfer systems for monopile foundation structures and more particularly in the case of offshore

wind turbine structures. Firstly, monopile foundation structures are smaller, and hence have smaller boat landings and maintenance platforms. This renders larger scale transfer systems used when accessing larger structures, such as an oil platform, unsuitable. Furthermore, because monopile foundation structures are unmanned, it is much more difficult to implement systems which rely on cranes and winches being actively controlled at the platform. For example, controlling such machinery remotely from the vessel results in new safety and maintenance issues being raised.

[0005] Accordingly, there is a need for an improved marine transfer apparatus that seeks to address the above problems, and in particular one that is directed to the specific technical considerations associated with monopile offshore structures.

[0006] According to a first aspect of the present invention, there is provided a marine transfer apparatus for transferring a body between a vessel subjected to waves and an offshore structure, the apparatus comprising: a transfer cable on which the body can ascend and descend in use; a structure coupling for connecting the transfer cable to an attachment point provided on the offshore structure; a vessel coupling for connecting the transfer cable to the vessel; and wherein the transfer cable is elastically extendable for extending its length when taut between the structure and vessel couplings as the vessel moves in the waves; and wherein one of the structure and vessel couplings comprises a reeling device for reeling the transfer cable between a taut state and a slack state when connected between the structure and vessel couplings.

[0007] In this way, when the transfer cable is connected between the structure and vessel, the reeling device allows the tension in the cable to be controlled to switch between a taut state and a slack state. This has the effect of switching the movement reference point from the vessel to offshore structure. To explain further, in the taut state, the elastic extendability of the transfer cable allows it to extend and contract with the movements of the vessel in the waves. As such, when a body is coupled to the transfer cable, it moves in unison with the cable's extensions and contractions in length, and hence its movement is coupled with movement of the vessel. In other words, the transfer cable is effectively stationary relative to the reference point of the vessel. As a consequence, a body is able to safely ascend the transfer cable from the vessel, as well as safely descend the transfer cable onto the vessel. Conversely, when the reeling device is operated to place the transfer cable in the slack state, the slack at the cable's second end accommodates the movements of the vessel in the waves, rather than this being accommodated by cable extension. As such, the transfer cable hangs down from the structure's attachment point without being influenced by movements of the vessel. In other words, the transfer cable is effectively stationary relative to the reference point of the offshore structure. As a consequence, a body is able to safely ascend the transfer

cable from the structure's platform, as well as safely descend the transfer cable onto the structure's platform. Here, it will be understood that even when the reeling device is operated to place the transfer cable in the slack state, the section between where the body is connected and its attachment to the structure may nevertheless still be taut in the sense that the body's weight will inherently pull the cable above it tight. However, the transfer cable as a whole is in a slack state in that the movements of the vessel in the waves are accommodated by a surplus of cable, rather than the cable extending in length.

[0008] Accordingly, with the above marine transfer apparatus, safe access to an offshore structure from a vessel can be achieved without needing a boat landing or ladder, and from any sized access vessel. It will be understood that the reeling device may switch the transfer cable between the taut and slack states by paying out or withdrawing sections of the transfer cable, for example by winding the transfer cable onto a cylinder or by drawing the cable through a pulley arrangement using, for instance, a piston actuator.

[0009] Preferably, the transfer cable comprises an extendable region and non-extendable region. In this way, the extendable region of the cable can provide the elastic extension of the transfer cable's overall length, while the non-extendable region is able to move with the vessel when in a taut state and resists stretching when gripped and loaded by a carrier during an ascent operation to allow for an easier ascent.

[0010] Preferably, the extendable region of the transfer cable is located at or adjacent the structure coupling. In this way, the extension of the transfer cable is focussed within the section of the cable closest to its attachment to the structure. At the same time, the non-extendable region adjacent the vessel is able to move with the vessel, whilst providing a non-stretchable material for facilitating an easier ascent.

[0011] Preferably, the extendable region comprises an elastic cable section or a spring. In this way, the transfer cable may be provided in two functional parts joined to form the length of cable. The extendable region may therefore be formed in a straightforward manner using an elastic material or spring. The non-extendable region may then be provided as a steel or polymer cable, or webbed strap, joined to the elastic or spring material of the extendable region.

[0012] Preferably, the reeling device comprises a winch. In this way, retracted sections of the transfer cable may be held in a compact arrangement when wound onto the winch cylinder. At the same time, the rotational position of the winch cylinder may be locked to maintain the transfer cable in a taut state and quickly pay out cable to switch to a slack state.

[0013] Preferably, the vessel coupling comprises the reeling device. In this way, actuation of the switching between the taut and slack states may be provided on the vessel itself, allowing for localised control and maintenance.

[0014] Preferably, the apparatus further comprises a carrier coupled to the transfer cable for moving the body on the transfer cable. In this way, the body may attach to the carrier, which can then in turn be driven to ascend or descend the cable. The carrier may be manually driven, for example, such as a climbing ascender/descender. In other embodiments, the carrier may comprise a lifting mechanism powered autonomously or from the vessel.

[0015] Preferably, the vessel coupling comprises a release device for rapidly releasing tension in the transfer cable. In this way, in the event of an excessive movement of the vessel in the water causing the transfer cable to be subjected to a tension above a tension limit, the release device may operate to rapidly release that tension. To achieve this, the release device may rapidly pay out cable from the reeling device and/or by breaking away the transfer cable from its connection to the vessel. This thereby provides an important safety feature to minimise the risk of injury to personnel, which could otherwise result from damage or failure of components within the apparatus, the vessel and/or the offshore structure.

[0016] Preferably, the structure coupling comprises a remote release mechanism for releasing the transfer cable from a stored position to a released position where the second end of the transfer cable may be attached to the vessel coupling. In this way, the transfer cable may be stored on the offshore structure, coupled to the attachment point, and then released remotely when needed by a vessel. For example, the transfer cable may be stored in a weatherproof box at the attachment point, and then released by actuating a latch to open a door and drop the second end of the transfer cable down.

[0017] Preferably, the offshore structure is a monopile offshore structure. Embodiments of the present invention are especially suitable for use with monopile offshore structures. For example, the apparatus may be used with smaller vessels and, since control may be implemented from the vessel side, there is no need for the platform to be manned.

[0018] In embodiments, the marine transfer apparatus further comprises a secondary rope for hanging from a secondary rope attachment point connected to the offshore structure, the secondary rope for connection to a climb assist device for driving the body to ascend the transfer cable. In this way, the secondary rope can be used to drive ascent operations using a climb assist device, when the transfer cable is in the slack state. Advantageously, this allows a greater variety of climb assist devices to be used with embodiments of the invention because the free end of the secondary rope is not taut. It will be understood that the secondary rope attachment point may be part of the structure coupling or be provided at the same attachment point on the offshore structure to which the transfer cable is coupled. Alternatively, the secondary rope may also attach to the transfer cable itself, and thereby be connected to the offshore structure through the transfer cable. It will also be understood that mechanisms used for driving the body, such as the carrier

and/or climb assist device, may be powered or manually operated.

[0019] According to a second aspect of the present invention, there is provided a method of transferring a body from a vessel subjected to waves to an offshore structure using the apparatus of any preceding claim, comprising: connecting the transfer cable between the structure coupling and the vessel coupling; operating the reeling device to reel the transfer cable to a taut state; operating a carrier coupled to the transfer cable to move the body for ascending the transfer cable from the vessel to an elevated position; operating the reeling device to reel the transfer cable to a slack state; and operating the carrier to move the body from the elevated position to the platform on the offshore structure.

[0020] In this way, when the body first ascends from the vessel, with the transfer cable in the taut state, the elastic extendability of the transfer cable allows it to extend and contract with the movements of the vessel in the waves. As such, the body is able to safely ascend away from the vessel. Once the body has reached the elevated position, which may be above the platform or clear of the platform and above the vessel, the reeling device may then be operated to place the transfer cable in the slack state. In this condition, the transfer cable no longer moves with the vessel, allowing the body to safely descend or further ascend onto the structure's platform. Furthermore, the action of paying out the transfer cable from the reeling device may also be used to elevate the body. In particular, by locking the carrier onto the transfer cable when taut, and then paying out a section of cable from the reeling device, a corresponding contraction of the extendable region will act to lift the body away from the vessel. Once suitably elevated, the carrier may then be operated to allow further ascent of the transfer cable, for example by being directly driven or in combination with a climb assist device engaged with a secondary rope.

[0021] Preferably, the elevated position is above the platform on the offshore structure, and the carrier is operated to move the body to descend the transfer cable from the elevated position to the platform on the offshore structure.

[0022] Preferably, the method further comprises the step of releasing the second end of the transfer cable from the vessel coupling. In this way, the vessel may move away from the structure to complete other operations. The second end of the transfer cable may be released once the reeling device has reeled the transfer cable to a slack state or once the body has descended from the elevated position onto the platform or ascended to the platform.

[0023] According to a third aspect of the present invention, there is provided a method of transferring a body from an offshore structure to a vessel using the above apparatus, comprising: operating a carrier coupled to the transfer cable, when the transfer cable is in a slack state, to move the body on the transfer cable from a platform

on the offshore structure to an elevated position; once the body is in the elevated position, operating the reeling device to reel the transfer cable to a taut state connected between the structure and vessel couplings; and operating the carrier to move the body for descending the transfer cable from the elevated position to the vessel.

[0024] In this way, when the body is to be transferred back to the vessel, it is able to safely climb to the elevated position from the platform, with the transfer cable not moving relative to the platform. Once the body has reached the elevated position, which may be above the platform or clear of the platform and above the vessel, the reeling device may then be operated to place the transfer cable in the taut state. In this condition, the transfer cable moves with the vessel, allowing the body to safely descend onto the vessel. It will be understood that transfer cable may be connected to the vessel coupling either prior to operating the carrier or once the body has ascended to the elevated position.

[0025] Preferably, the elevated position is above the platform on the offshore structure.

[0026] Preferably, the method further comprises releasing the second end of the transfer cable from the vessel coupling. In this way, once the body has safely reached the vessel, the vessel may move away from the structure to complete other operations.

[0027] In embodiments, the above methods may further comprise the steps of: providing a secondary rope hung from a secondary rope attachment point connected to the offshore structure; connecting a climb assist device to the secondary rope; and operating the climb assist device to drive movement of the body on the transfer cable. In this way, the secondary rope can be used to drive ascent operations using a climb assist device. Advantageously, this allows a greater variety of climb assist devices to be used with embodiments of the invention because the free end of the secondary rope is not taut. It will be understood that the secondary rope attachment point may be part of the structure coupling or be provided at the same attachment point on the offshore structure to which the transfer cable is coupled, or on the transfer cable itself.

[0028] Preferably, the offshore structure is a monopile offshore structure. The above methods are particularly applicable to monopile offshore structures.

[0029] According to a fourth aspect of the present invention, there is provided a method of transferring a body from a vessel subjected to waves to an offshore structure comprising: connecting the transfer cable between the structure coupling and the vessel coupling; operating the reeling device to reel the transfer cable to a taut state, wherein the vessel coupling comprises the reeling device; securing the body to the transfer cable using a harness; operating the reeling device to reel the transfer cable to a slack state for ascending the body on the transfer cable from the vessel to an elevated position.

[0030] According to an alternative solution, there is provided a method of transferring a body from a vessel

subjected to waves to an offshore structure, comprising: connecting a transfer cable between a structure coupling and a vessel coupling; slidably coupling a carrier to the transfer cable for carrying the body; and driving the carrier along the transfer cable using a driver. In examples, the transfer cable may be connected in a slack state between the structure coupling and a vessel coupling for accommodating movements of the vessel. In other examples, the transfer cable may comprise an extendable section having a spring or counterweight mechanism for accommodating movements of the vessel. The structure coupling and/or vessel coupling may be located above a structure platform and a vessel platform, respectively. The structure coupling and/or vessel coupling may be spaced above their respective platforms by a safety distance for avoiding contact between the platform and the body when connected to the carrier. The method may further comprise lifting the body up from the structure platform and/or vessel platform to the carrier before driving the carrier along the transfer cable. The method may further comprise lowering the body down to the structure platform and/or vessel platform from the carrier after driving the carrier along the transfer cable. The carrier may comprise a lift mechanism for lifting and/or lowering the body between the carrier and the structure platform and/or vessel platform. In examples, the driver acts on the transfer cable to drive the carrier. In other examples, the method may further comprise connecting a secondary cable to the offshore structure, wherein said driver acts on the secondary cable to drive the carrier. The secondary cable may be connected between the vessel and the offshore structure.

[0031] Illustrative embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Figures 1 (a) to (d) show schematic illustrations of the marine transfer apparatus according to an embodiment of the invention during an ascent operation from a vessel to a monopile wind turbine generator; and

Figures 2 (a) to (d) show schematic illustrations of the marine transfer apparatus according to an embodiment of the invention during a descent operation from a monopile wind turbine generator to a vessel; Figure 3 shows a schematic illustration of a marine transfer apparatus according to a second embodiment of the invention;

Figure 4 shows a schematic illustration of a marine transfer apparatus according to a third embodiment of the invention;

Figure 5 shows a schematic illustration of a marine transfer apparatus according to a fourth embodiment of the invention; and

Figure 6 shows a schematic illustration of a marine transfer apparatus according to an alternative solution.

[0032] Figure 1(a) shows a schematic illustration of a marine transfer apparatus according to an embodiment of the invention. The marine transfer apparatus is used to transfer a body 7, such as a person or object, between a marine vessel 6 and an offshore structure 10, in this case a monopile wind turbine generator. As will be understood, marine vessels 6, such as boats and ships, are subjected to waves in the sea 9, which causes their position to vary dynamically relative to a static reference point, like the monopile wind turbine generator 10.

[0033] The marine transfer apparatus comprises a transfer cable 1 which includes an extendable region 3 and a non-extendable region 2. The extendable region 3 is elastically extendable and is located at a first end of the transfer cable 1 and connects, via coupling 4, to a hook-on arm 12 provided on the body of the wind turbine generator 10 above its platform 11. As such, the hook-on arm 12 provides an attachment point for the wind turbine generator 10. The hook-on arm 12 may be provided as a swing arm to allow for easier access to the platform 11. In this embodiment, the extendable region 3 is provided as a tension spring, although other embodiments may use other arrangements, such as other types of spring, elastic materials, or piston arrangements. The non-extendable region 2 is joined to the extendable region 3 and is located at a second end of the transfer cable 1 and connects, via coupling 5, to the vessel 6. In this embodiment, the non-extendable region 2 is provided as a nylon cable, although other embodiments may use other materials, such as other polymer ropes or steel wire.

[0034] The vessel coupling 5 connects the second end of the transfer cable 1 to the vessel 6 and comprises a reeling device 8 for reeling the transfer cable 1. In this embodiment, the reeling device 8 is provided as a winch, although other mechanisms are also envisaged. The reeling device 8 may retract and pay out sections of the transfer cable 1, such that, when the transfer cable 1 is connected between the structure coupling 4 and vessel coupling 5, it can be switched between a taut state and a slack state.

[0035] When the transfer cable 1 is in the taut state, it is pulled tight between the structure coupling 4 and vessel coupling 5. However, the elastically extendable region 3 is sufficiently extendable to accommodate the movement of the vessel 6 in the sea 9. As such, the elastically extendable region 3 is stretched further when the vessel 6 moves down relative to the wind turbine generator 10, and contracts back when the vessel 6 moves up relative to the wind turbine generator 10. In this state, the non-extendable region 2 therefore moves up and down with the vertical movements of the vessel 6.

[0036] An ascent operation using the illustrative embodiment will now be described in reference to Figures 1 (a) to (d). As shown in Figure 1(a), the vessel 6 may arrive at the wind turbine generator 10, and may optionally also push on to the monopile foundation to minimise its movement. At this stage, a remote trigger may be used to release the transfer cable 1 from a stored position in

a weatherproof box provided on the hook-on arm 12. This causes the second end of the transfer cable 1 to drop down to the vessel 6, with the first end connected to the hook-on arm 12 via structure coupling 4, and the hanging cable 1 slack. The second end of the transfer cable 1 may then be connected to the reeling device 8 of vessel coupling 5. It will be understood that, although in this embodiment the transfer cable 1 is retained at the structure coupling 4, other arrangements are also envisaged. For example, in another embodiment, the transfer cable 1 is retained at the vessel coupling 5 and the structure coupling 4 is provided with a guide rope that is used to connect the transfer cable 1. An advantage with such an arrangement is that only one transfer cable 1 and one carrier device 13 is needed per vessel, and the installation and maintenance required at the wind turbine generator 10 is minimised.

[0037] In Figure 1(b), the reeling device 8 is driven to reel in the transfer cable 1 so that it is taut between the vessel coupling 5 and structure coupling 4. In this state, the non-extendable region 2 moves up and down with the vertical movements of the vessel 6, with the elastically extendable region 3 accommodating this movement.

[0038] As shown in Figure 1(c), the body 7, may then ascend the non-extendable region 2 of the transfer cable 1 using a carrier 13, such as a climbing ascender/descender. Once the body 7 has ascended to an elevated position above the platform 11, the reeling device 8 may then be operated to reel out the transfer cable 1 to introduce slack between the body 7 and the vessel 6.

[0039] As shown in Figure 1(d), with the transfer cable 1 slack between the body 7 and the vessel 6, it no longer moves with the vessel 6. As such, the body 7 may safely descend onto the platform 11 by operating the carrier 13.

[0040] A descent operation using the illustrative embodiment will now be described in reference to Figures 2(a) to (d). As shown in Figure 2(a), the vessel 6 positions itself at the wind turbine generator 10, and may optionally push on to the monopile foundation to minimise its movement. At this initial stage, the transfer cord 1 is in a slack condition, either because it is not yet connected to the reeling device 8 or because the reeling device 8 is operated to place the transfer cord 1 in the slack state. Figure 2(a) shows the situation where the transfer cord 1 is already connected to the reeling device 8 and the reeling device 8 is operated to place the transfer cord 1 in the slack state.

[0041] The carrier 13 is then coupled to the slack transfer cable 1 and, as shown in Figure 2(b), is operated to lift the body 7 to ascending the transfer cable 1 from a platform 11.

[0042] Once the body 7 reaches the elevated position shown in Figure 2(c), the reeling device 8 is operated to reel in the transfer cable 1 to a taut state. It will be understood that, if the transfer cable 1 was not already connected to the reeling device 8, it will need to be connected before it is reeled in.

[0043] As shown in Figure 2(d), with the transfer cable

1 taut, it now moves with the vessel 6, thereby allowing the body 7 to safely descend from the elevated position down to the vessel 6.

[0044] Accordingly, with the above arrangement, the movement reference point for an ascending or descending body 7 can be switched between the vessel 6 and the offshore structure 10. As such, when a body 7 is on the transfer cable 1 adjacent to the vessel 6, it or they move in unison with the vessel 6. Conversely, when body 7 is on the transfer cable 1 adjacent to the structure's platform 11, it isn't influenced by movements of the vessel 6. As a result, a body 7 is able to safely transition between the vessel 6 and the structure's platform 11. Advantageously, this may significantly reduce the risk of injury to personnel, and may be implemented from any sized access vessel 6, without needing a boat landing or ladder to be provided on the offshore structure 10.

[0045] It will be understood that the embodiment illustrated above shows an application of the invention only for the purposes of illustration. In practice the invention may be applied to many different configurations, the detailed embodiments being straightforward for those skilled in the art to implement.

[0046] In this connection, for example, Figure 3 shows a schematic illustration of a second embodiment of the invention. This embodiment is similar to the embodiment shown in Figures 1 and 2, with like reference numerals referencing common features. However, in this embodiment, the apparatus is further provided with a secondary rope 14, which hangs down from its fixture on the hook-on arm 12. The secondary rope 14 is coupled to a climb assist device 15 used to drive the ascent once the transfer cable is in the slack state, rather than this being driven by a mechanism within carrier 13. In particular, the carrier 13 is provided as a fall arrest mechanism to which a body is attached. During an ascent operation, the fall arrest mechanism 13 supports the body's weight when it is not being actively driven. Once the body 7 is clear of the vessel 6 and the transfer cable 1 is in the slack state, the climb assist device 15 may then be engaged with the secondary rope 14 and driven to pull the body 7 upwards. During a descent operation, the fall arrest mechanism 13 and/or the climb assist device 15 may be operated to control the speed of descent. As with the first embodiment, the transfer cable 1 may be switched between the taut and slack states depending on whether the body 7 is adjacent to the vessel 6 or the structure's platform 11. Importantly, with this embodiment, as the secondary rope 14 is not taut below the climb assist device 15, a greater range of ascent devices may thereby be used. For example, some climb assist devices rely on the engaged rope being driven through a perpendicular path as it passes through the climb assist device's rope guide and tensioner assembly. As such, the provision of a secondary rope 14, hung from the offshore structure with a free end, allows embodiments of the present invention to be used in conjunction with such climb assist devices.

[0047] In the above example, the secondary rope's at-

tachment point on the hook-on arm 12 is separated from the structure coupling 4. However, in other embodiments, these attachment points may be the same or adjacent to one another. Furthermore, the secondary rope's attachment point may also be provided at the joint between the extendable and non-extendable sections of the transfer cable 1, or on the non-extendable section 2 itself.

[0048] In this connection, Figure 4 shows a schematic illustration of a marine transfer apparatus according to a third embodiment of the invention. This third embodiment is substantially identical to the second embodiment shown in Figure 3, except that the secondary rope 14 is attached at the joint of this section to the extendable section 3. That is, the joint between these functional parts comprises a hook-on point for attaching the secondary rope 14. In other embodiments, the secondary rope 14 could be attached further down the non-extendable section 2. For the purposes of simplifying illustration, the secondary rope 14 has been drawn separated from the non-extendable section 2 of transfer cable 1. However, it will be understood that in practice, the secondary rope 14 and non-extendable section 2 may hang down substantially parallel to one another, spaced by the separation between the carrier 13 coupled to the non-extendable section 2 and the climb assist device 15 coupled to secondary rope 14. As with the second embodiment above, because the secondary rope 14 is not connected to the reeling device, it remains slack below the climb assist device 15, independent of whether the transfer cable 1 is in its taut or slack states. This allows a greater range of climb assist devices to be used, whilst advantageously allowing the secondary rope 14 to move with the non-extendable section 2 when the transfer cable 1 is in its taut state.

[0049] As with the transfer cable 1, the secondary rope 14 may be retained at the hook-on arm 12, or may be retained on the vessel and connected to the structure using a guide rope. Furthermore, the secondary rope 14 may be made from, for example, nylon, other polymer ropes and webbing, or from steel wire.

[0050] It will also be understood that safety and/or guide cables may be additionally be used in conjunction with the above arrangements. For example, a fail-safe cable may be provided between the non-extendable section 2 and the hook-on arm 12 to secure the transfer cable 1 in the event that the extendable section 3 were to fail. That is, the fail-safe cable would be sufficiently slack to allow the extendable section 3 to extend in use, but in the event that the extendable section 3 were to break, it provides a bypass connection between the non-extendable section 2 and the hook-on arm 12. This may therefore ensure that any personnel climbing the cable are not dropped in the event of a cable failure.

[0051] Figure 5 shows a schematic illustration of a marine transfer apparatus according to a fourth embodiment of the invention. In this embodiment, the transfer cable 1 is provided from an elastically extendable material connecting between the vessel 6 and the offshore structure

10. In this embodiment, the structure coupling 4 is provided with a pulley connected to the hook-on arm 12. The pulley 4 feeds the transfer cable 1 around and back down to the vessel 6. On the vessel, the transfer cable 1 is connected to coupling 5, which comprises first and second reeling devices 8a and 8b for reeling in and out lengths of the transfer cable 1 for varying the tension in the transfer cable connecting between the vessel coupling 5 and structure coupling 4.

[0052] During an ascent operation, the transfer cable 1 is placed in a taut state by retracting a section of the transfer cable 1 into first reeling device 8a. At this point, second reeling device 8b may either lock its end of the transfer cable 1, or additionally retract a section of the transfer cable 1 to further increase the tension between the vessel coupling 5 and structure coupling 4. Nevertheless, as with other embodiments, even when the transfer cable 1 is pulled tight between the structure coupling 4 and vessel coupling 5, the cable 1 is still sufficiently elastically extendable to accommodate the movement of the vessel 6 in the sea 9. As such, the transfer cable 1 is stretched further when the vessel 6 moves down relative to the offshore structure 10, and contracts back when the vessel 6 moves up relative to the offshore structure 10.

[0053] Once the transfer cable 1 is in the taut state, the body 7 may be secured onto the transfer cable 1 for example utilising relevant safety equipment such as harness 16 and fall arrest. The safety equipment, for example, a harness 16 grips a portion of the transfer cable 1, locking it thereto. At this stage, the first reeling device 8a can be operated to pay out the transfer cable 1. As transfer cable 1 material is payed out, the stretched tensioned transfer cable 1 contracts such that the portion of the transfer cable 1 gripped by the safety equipment, for example a harness 16 moves upwards toward the structure coupling 4. This acts to lift the body 7 away from the vessel 6. The rate of ascent can be varied by controlling the rate of paying out the transfer cable from the first reeling device 8a. As the elastic energy stored in the transfer cable is transferred into lifting the body 7, the body 7 is lifted to an elevated position above the platform 11. Once in the elevated position, the transfer cable 1 will be slack, and the body 7 may be detached from the transfer cable 1. The second reeling device 8b may be operated to reel out the transfer cable 1 to further introduce slack to facilitate the body's decent onto the platform 11.

[0054] During descent, the body 7 may be similarly secured onto the transfer cable 1 using for example relevant safety equipment such as a harness 16 and fall arrest and the first reeling device 8a may be operated to reel in the transfer cable 1, transitioning the transfer cable into a taut condition where it moves with the vessel 6.

[0055] As with previous embodiments, the movement reference point for an ascending or descending body 7 can be switched between the vessel 6 and the offshore structure 10. As such, when a body 7 is on the transfer

cable 1 adjacent to the vessel 6, it or they move in unison with the vessel 6. Conversely, when body 7 is on the transfer cable 1 adjacent to the structure's platform 11, it isn't influenced by movements of the vessel 6. As a result, a body 7 is able to safely transition between the vessel 6 and the structure's platform 11. Advantageously, this may significantly reduce the risk of injury to personnel.

[0056] It will be understood that an ascender/descender may also be used with the arrangement shown in Figure 5. That is, the ascender/descender or climb assist device may be attached to the transfer cable 1 and the body 7 may travel along the transfer cable 1 using this. The body 7 may then unhook from the ascender/descender to access the structure's platform 11 or vessel 6. The ascender/descender may be self-controlled by the user 7 or remotely controlled from the vessel 6. As with previous embodiments, safety and/or guide cables may additionally be used in conjunction with the above arrangement. In addition, as with previous embodiments, a basket may be fitted to the relevant safety equipment such as harness 16 and fall arrest to carry multiple people or other loads, as well as provide additional collision protection.

[0057] Figure 6 shows a schematic illustration of a marine transfer apparatus according to an alternative solution. With this arrangement, a transfer cable 1 is connected between a coupling 5 on the vessel 6 and a structure coupling 4 provided on hook-on arm 12. The transfer cable 1 is secured in a slack state or, in alternative arrangements, may be provided as an extendable section using a spring or counterweight mechanism. As such, the vessel 6 is able to move relative to the offshore structure 10 without damage to the cable 1 as the movement is absorbed either by the slack or the extension of the transfer cable 1. In this illustrative example, the vessel coupling 5 is located at the rear of the vessel 6 and at an elevated position, in this instance above the ship's bridge. As such, a relatively shallow angle of ascent may be achieved up to the structure's platform 11, which thereby mitigates the relative movement a body 7 connected to the transfer cable 1.

[0058] In this respect, a user or other body 7 connects to the transfer cable 1 using a climb assist device or tram 16 which slidably couples onto the cable 1. As such, the transfer cable 1 carries the load of the body 7 as it is moved between the vessel 6 and the platform 11. In this example, a secondary wire 14 connected between the vessel and the hook-on arm 12 is further provided to function as a pull wire. That is, the secondary wire 14 may be connected in a slack state and a climb assist device 15 can be coupled to it as a driver for driving movement of a climb assist device or tram 16 along the transfer cable 1. Such a secondary wire 14 also provides redundancy in the event of a cable failure. In other examples, a powered tram 16 may instead be provided to propel its own movement along the cable 1.

[0059] In use, with the arrangement shown in Figure

6, a user 7 on the vessel 6 will couple the tram 16 to the transfer cable 1 and the climb assist device 15 to the secondary wire 14. At this stage, the user will be moving in phase with movements of the vessel 6. The climb assist device may then be operated to pull the tram 16 and hence the user 7 along the transfer cable 1 toward the structure coupling 4. Once the tram 16 reaches the structure coupling 4, it can be locked to the hook-on arm 12 such that the user 7 is substantially stationary relative to the offshore structure 10, at which point the user 7 can unhook.

[0060] With the above arrangement, the vessel coupling 5 and structure coupling 4 may be set an additional height above the respective surfaces of the vessel 6 and offshore structure 10 from which the user 7 ascends and descends. This provides a safety distance such that, once the user 7 is connected to the tram 16, they are sufficiently distanced from parts of the vessel 6 or structure 10 to mitigate the risk of impacting these surfaces with movements of the vessel 6. For example, a user may need to ascend vertically, more preferably by 1-2m before the tram 16 can be released to allow transfer between the vessel 6 and the structure 10. A vertical lift/drop mechanism may additionally be provided for this purpose to lift the user 7 away from the surfaces during the initial lift off phase and drop the user 7 back down to the surface at the end of a transfer operation the vessel 6 and the structure's platform 11. Again, a basket may be fitted to the tram 16 to carry multiple people or other loads, as well as provide additional collision protection.

Claims

1. Marine transfer apparatus for transferring a body between a vessel subjected to waves and an offshore structure, the apparatus comprising:
 - a transfer cable on which the body can ascend and descend in use;
 - a structure coupling for connecting the transfer cable to an attachment point provided on the offshore structure;
 - a vessel coupling for connecting the transfer cable to the vessel; and
 - wherein the transfer cable is elastically extendable for extending its length when taut between the structure and vessel couplings as the vessel moves in the waves; and
 - wherein one of the structure and vessel couplings comprises a reeling device for reeling the transfer cable between a taut state and a slack state when connected between the structure and vessel couplings.
2. Marine transfer apparatus according to claim 1, wherein the transfer cable comprises an extendable region and non-extendable region.

3. Marine transfer apparatus according to claim 2, wherein the extendable region of the transfer cable is located at or adjacent the structure coupling.
4. Marine transfer apparatus according to claim 2 or 3, wherein the extendable region comprises an elastic cable section or a spring.
5. Marine transfer apparatus according to any preceding claim, wherein the reeling device comprises a winch.
6. Marine transfer apparatus according to any preceding claim, wherein the vessel coupling comprises the reeling device.
7. Marine transfer apparatus according to any preceding claim, further comprising a carrier coupled to the transfer cable for moving the body on the transfer cable.
8. Marine transfer apparatus according to any preceding claim, wherein the vessel coupling comprises a release device for rapidly releasing tension in the transfer cable.
9. Marine transfer apparatus according to any preceding claim, wherein the structure coupling comprises a remote release mechanism for releasing the transfer cable from a stored position to a released position where the second end of the transfer cable may be attached to the vessel coupling.
10. Marine transfer apparatus according to any preceding claim, wherein the offshore structure is a monopile offshore structure.
11. Marine transfer apparatus according to any preceding claim, further comprising a secondary rope for hanging from a secondary rope attachment point connected to the offshore structure, the secondary rope for connection to a climb assist device for driving the body to ascend the transfer cable.
12. A method of transferring a body from a vessel subjected to waves to an offshore structure using the apparatus of any preceding claim, comprising:
 - connecting the transfer cable between the structure coupling and the vessel coupling;
 - operating the reeling device to reel the transfer cable to a taut state;
 - operating a carrier coupled to the transfer cable to move the body for ascending the transfer cable from the vessel to an elevated position;
 - operating the reeling device to reel the transfer cable to a slack state; and
 - operating the carrier to move the body on the
- transfer cable from the elevated position to the platform on the offshore structure.
13. A method of transferring a body from an offshore structure to a vessel using the apparatus of any one of claims 1-11, comprising:
 - operating a carrier coupled to the transfer cable, when the transfer cable is in a slack state, to move the body from a platform on the offshore structure to an elevated position;
 - once the body is in the elevated position, operating the reeling device to reel the transfer cable to a taut state connected between the structure and vessel couplings; and
 - operating the carrier to move the body for descending the transfer cable from the elevated position to the vessel.
14. A method according to claim 12 or 13, further comprising the steps of:
 - providing a secondary rope hung from a secondary rope attachment point connected to the offshore structure;
 - connecting a climb assist device to the secondary rope; and
 - operating the climb assist device to drive movement of the body on the transfer cable.
15. A method of transferring a body from a vessel subjected to waves to an offshore structure using the apparatus of any of claims 1 to 10, comprising:
 - connecting the transfer cable between the structure coupling and the vessel coupling;
 - operating the reeling device to reel the transfer cable to a taut state, wherein the vessel coupling comprises the reeling device;
 - securing the body to the transfer cable using safety equipment;
 - operating the reeling device to reel the transfer cable to a slack state for ascending the body on the transfer cable from the vessel to an elevated position.

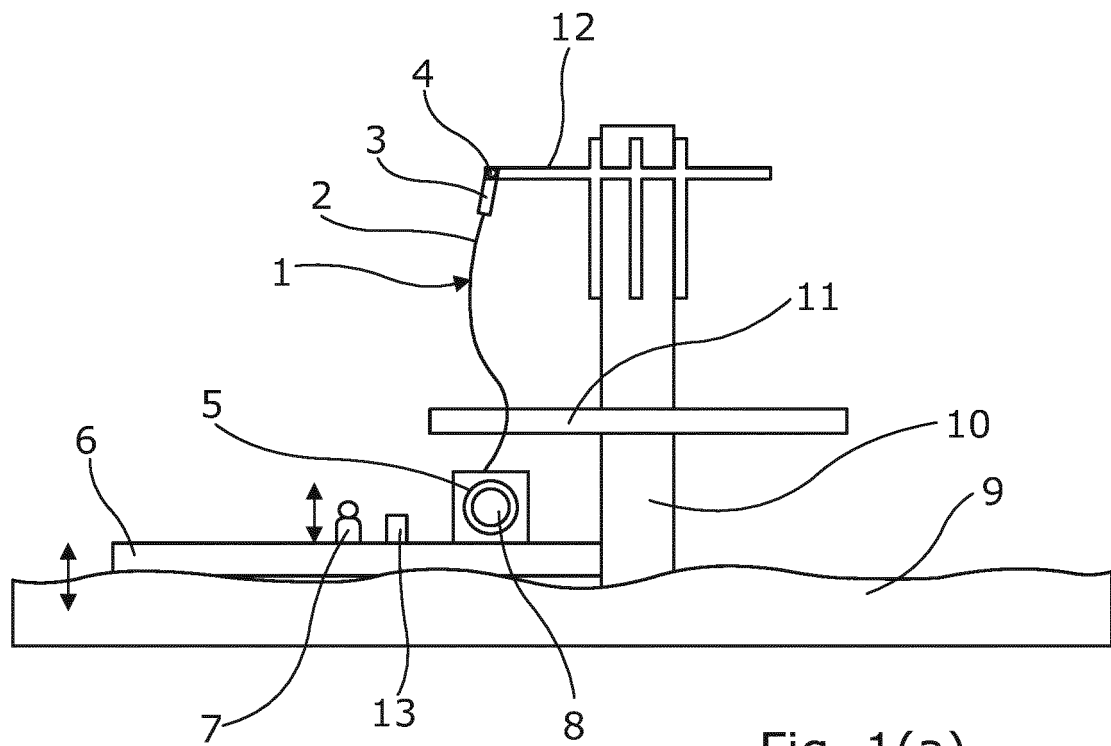


Fig. 1(a)

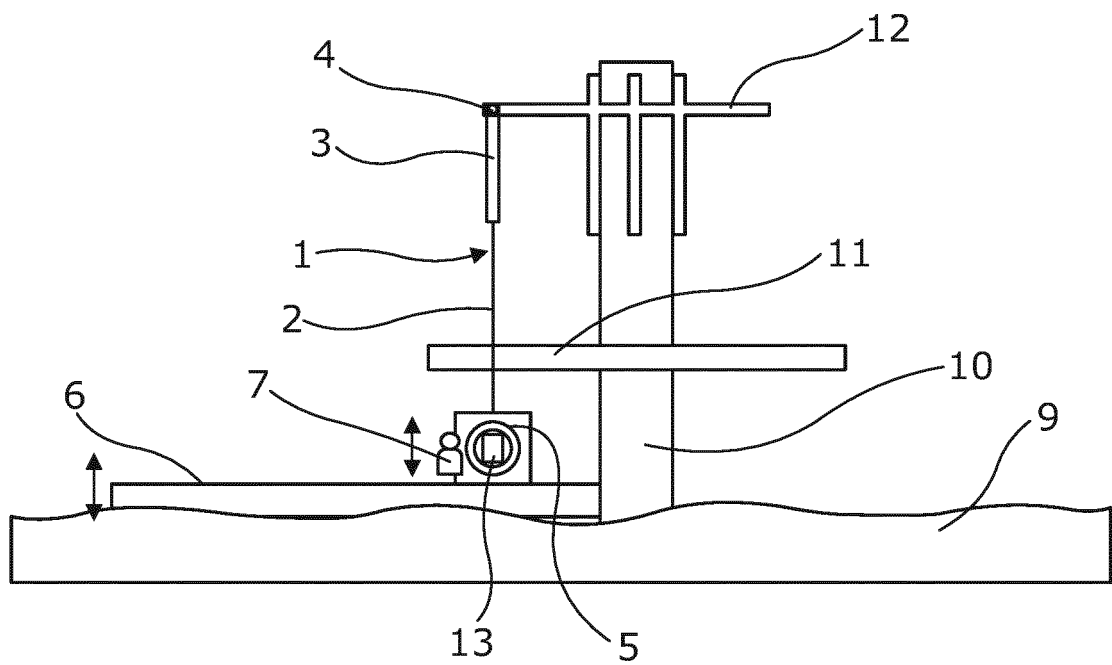


Fig. 1(b)

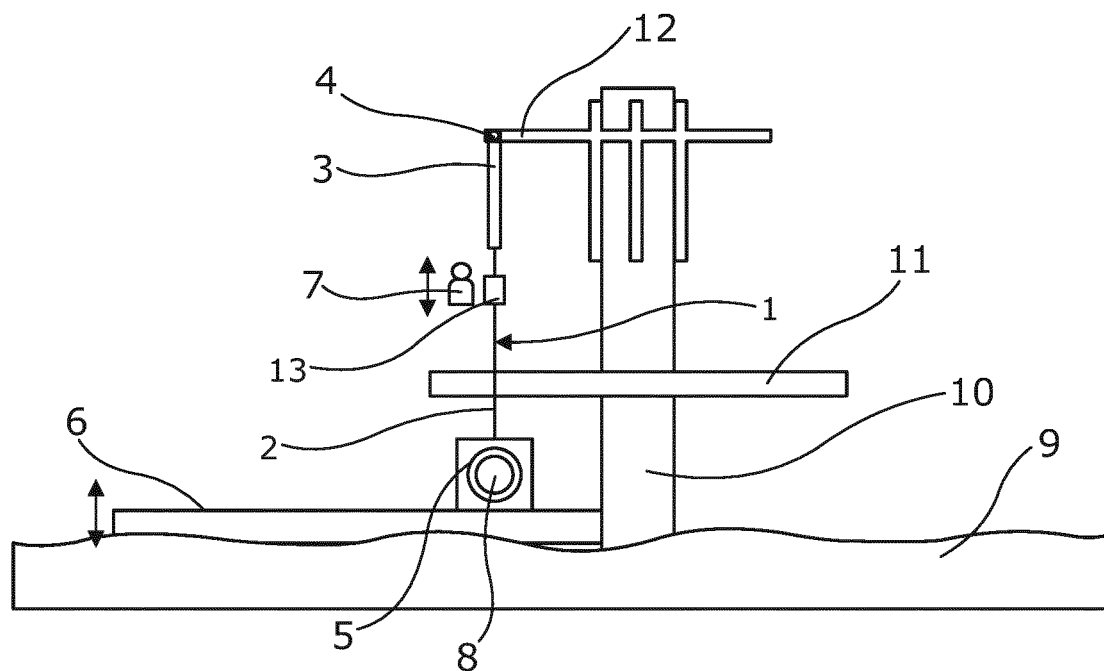


Fig. 1(c)

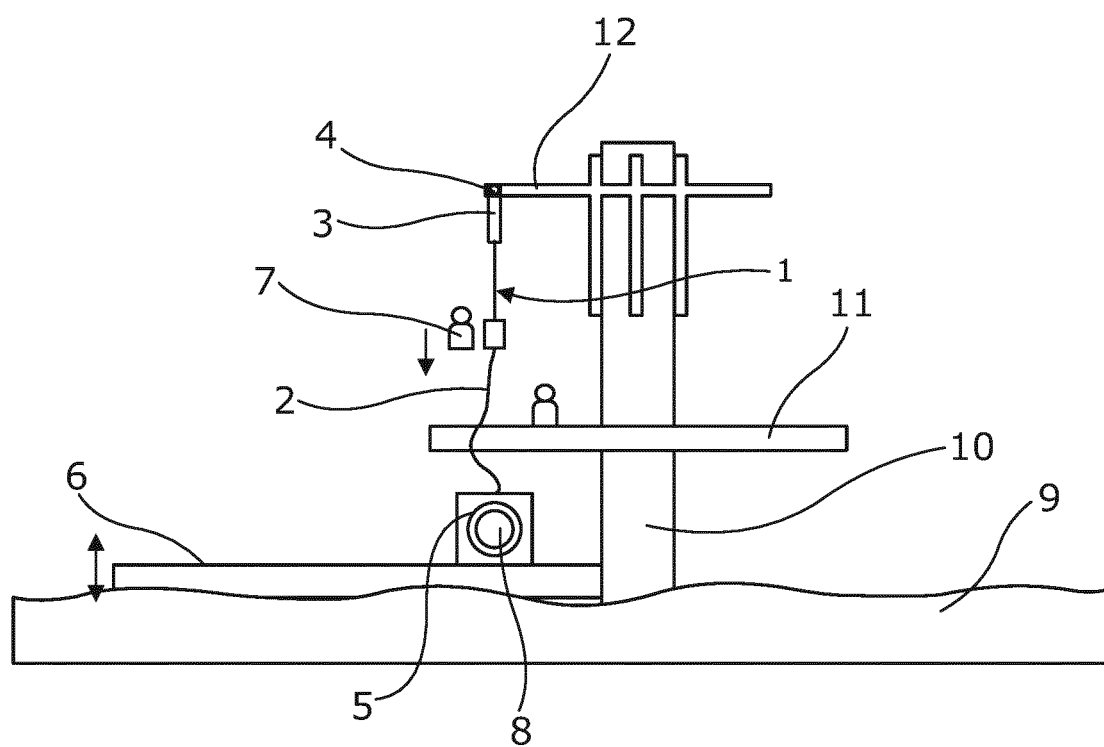


Fig. 1(d)

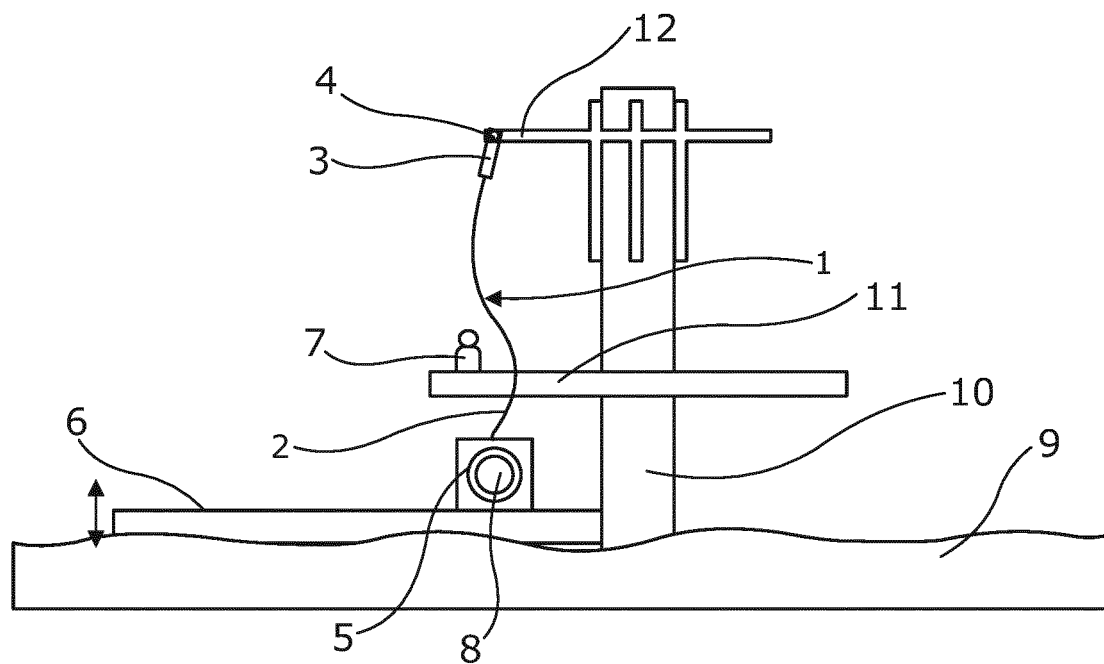


Fig. 2(a)

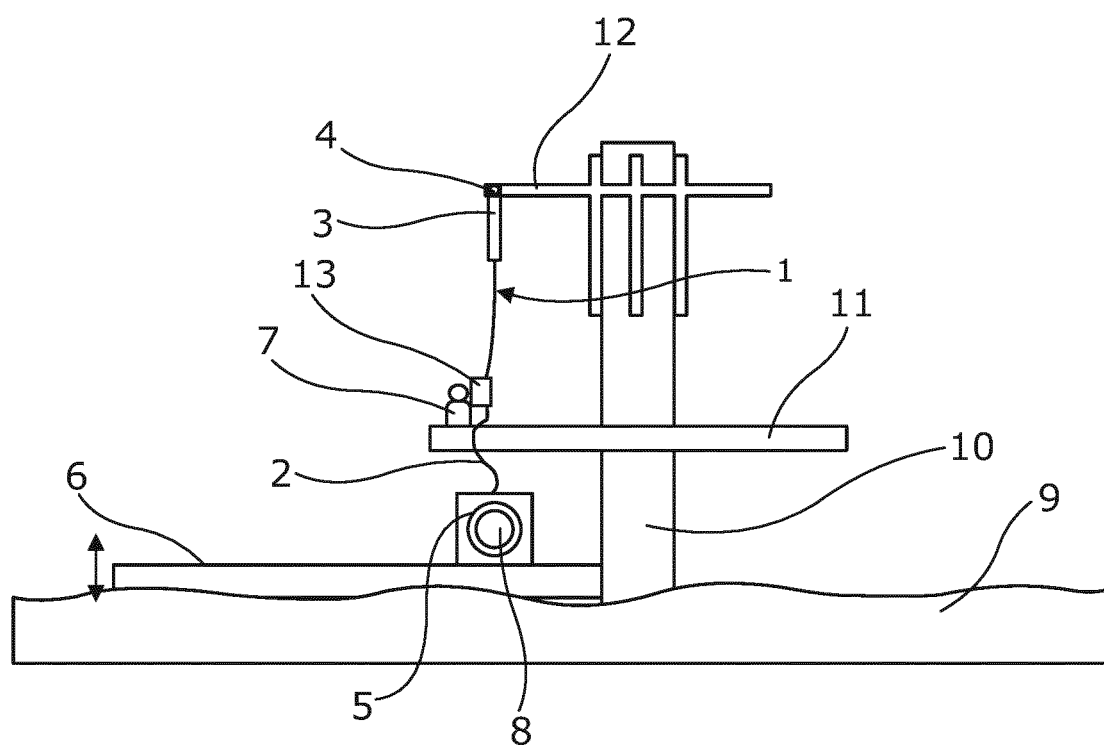


Fig. 2(b)

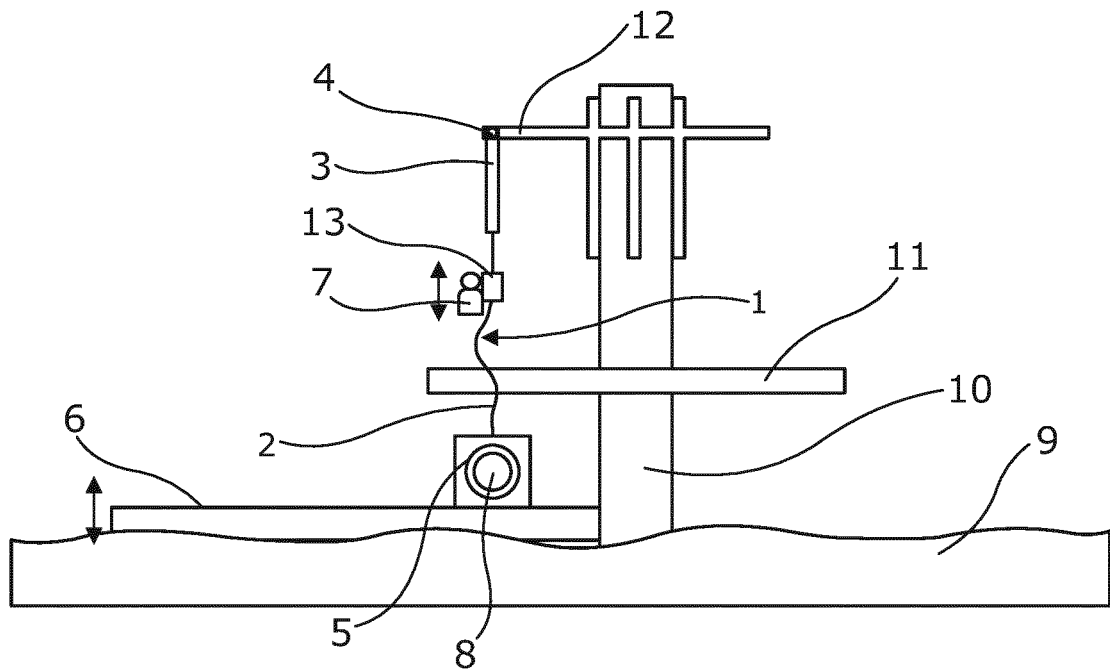


Fig. 2(c)

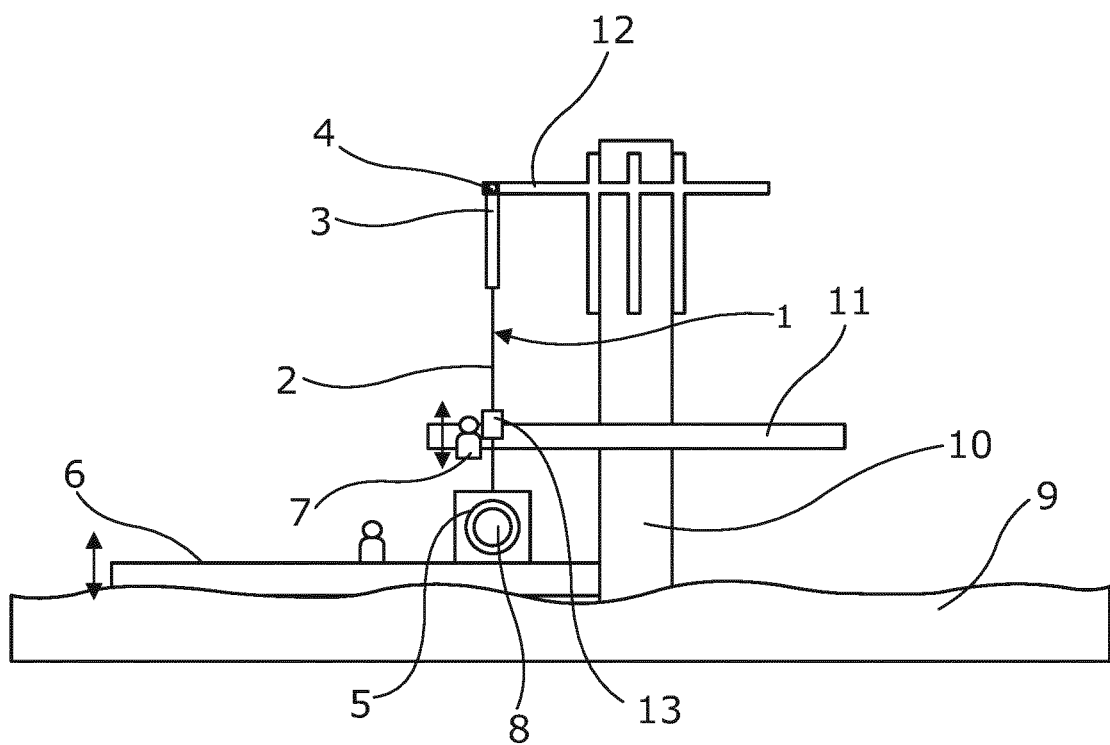


Fig. 2(d)

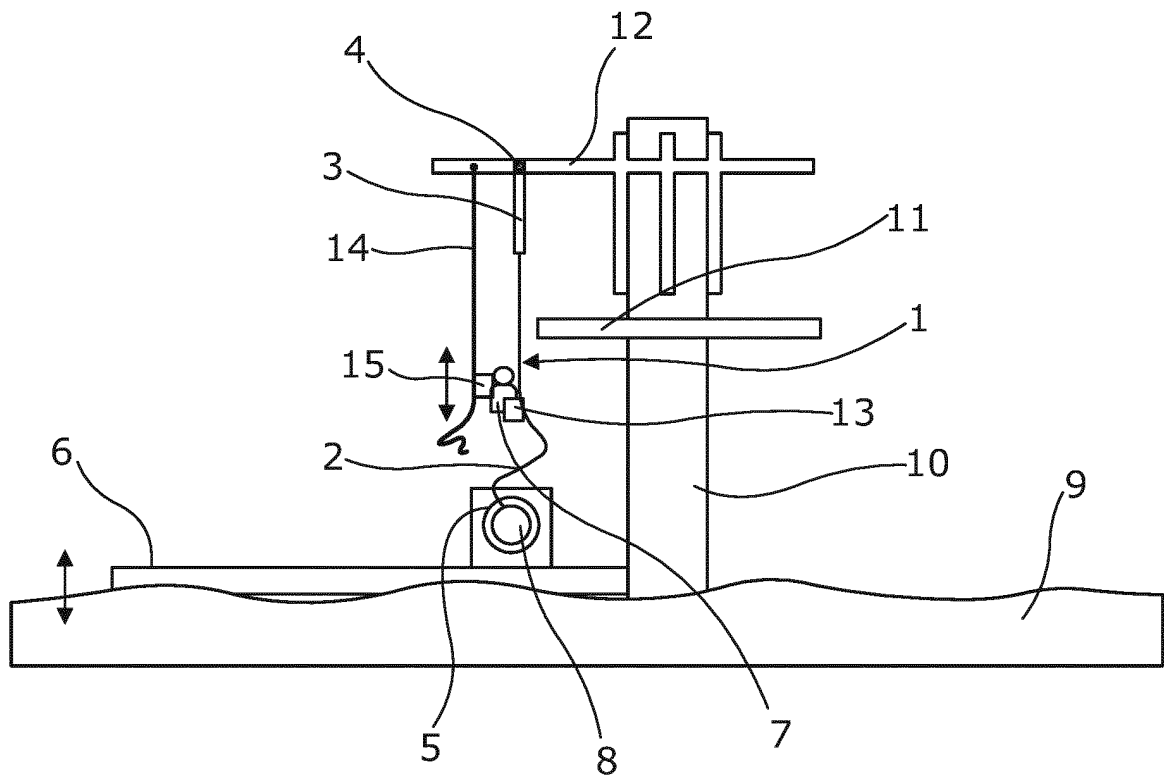


Fig. 3

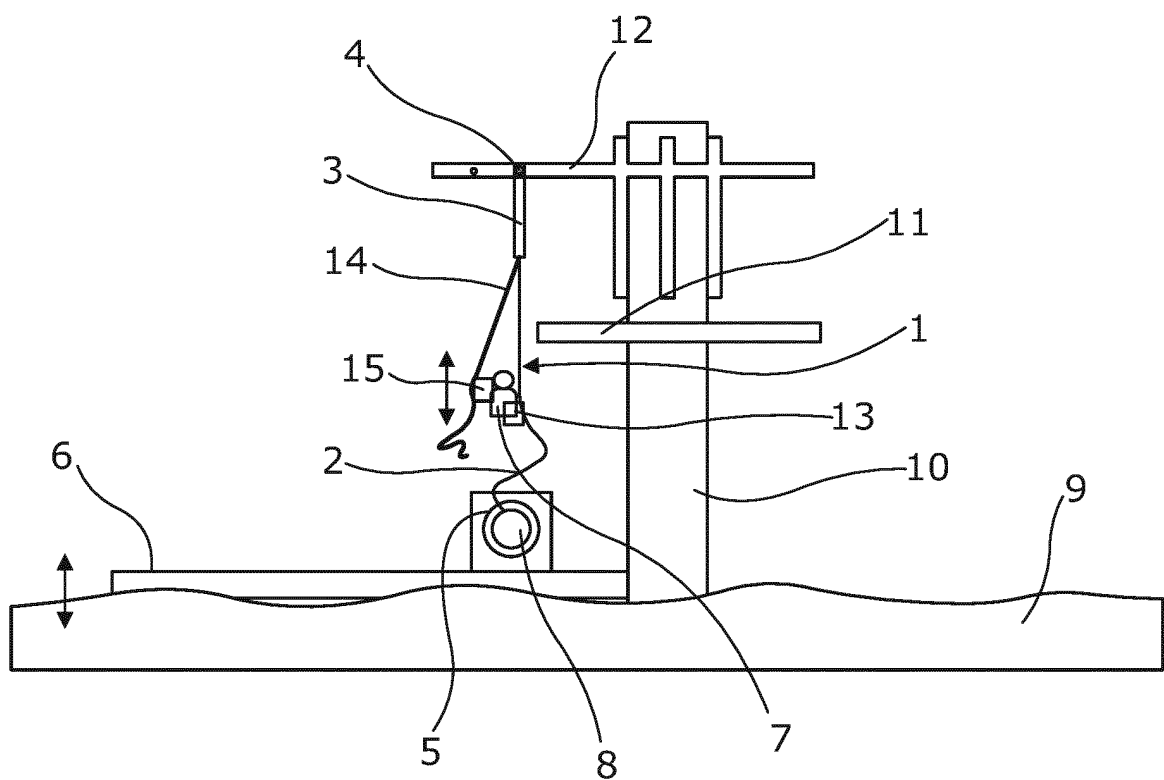


Fig. 4

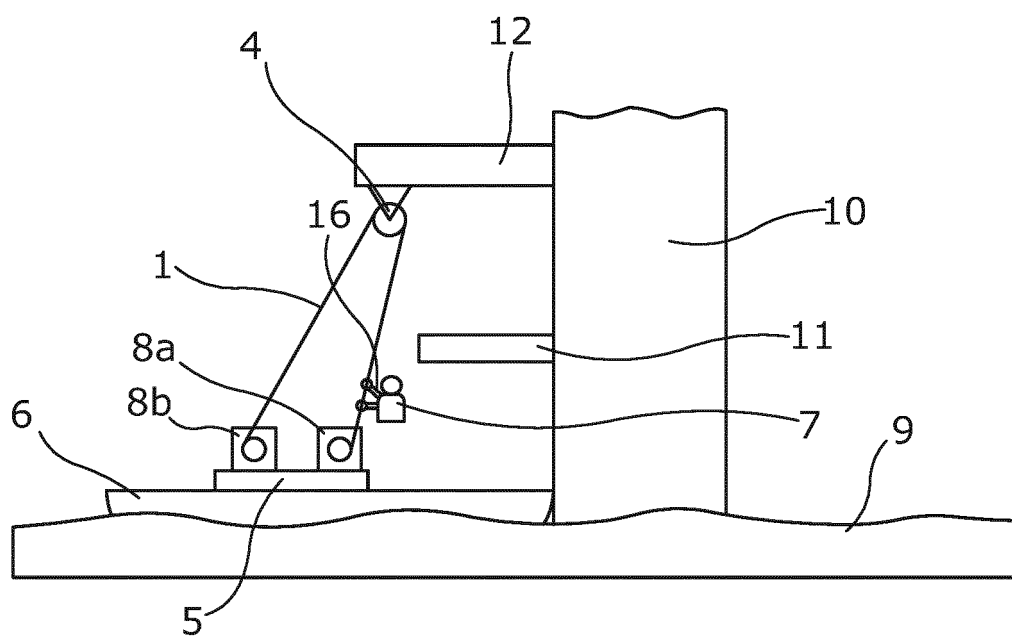


Fig. 5

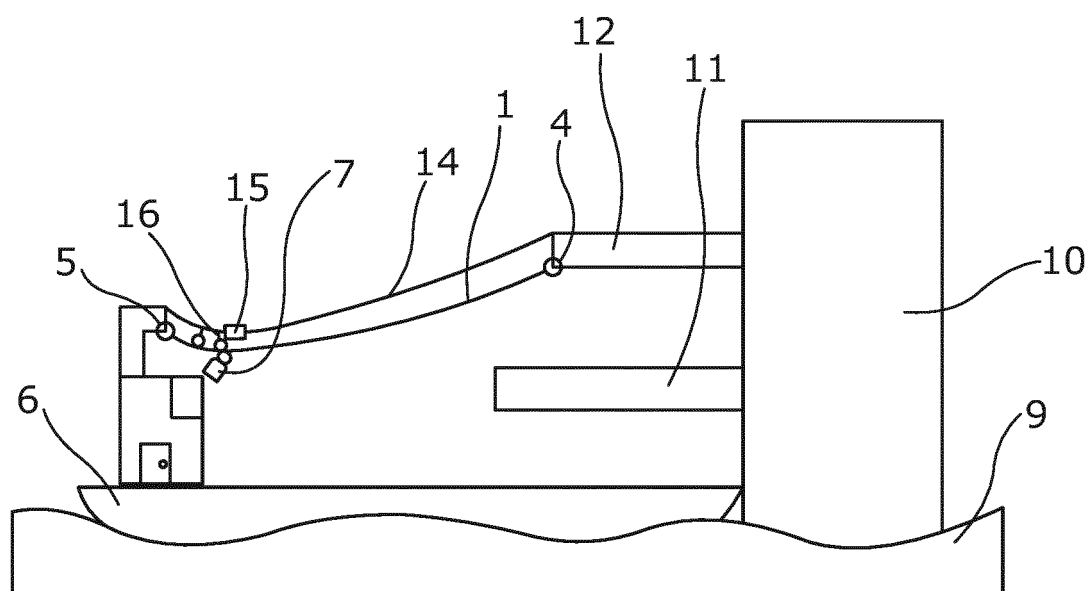


Fig. 6



EUROPEAN SEARCH REPORT

 Application Number
 EP 20 16 7326

5

10

15

20

25

30

35

40

45

50

55

2

EPO FORM 1503 03.82 (P04C01)

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2014 000041 A1 (I A U INST FÜR ARBEITSWISSENSCHAFT UND UNTERNEHMENSOPTIMIERUNG GMBH [D]) 9 July 2015 (2015-07-09) * paragraphs [0001] - [0022]; claims; figures *	1-11,15	INV. B63B27/18 B63B27/32
A	----- EP 2 151 375 A1 (XEMC DARWIND BV [NL]) 10 February 2010 (2010-02-10) * claims; figures *	12-14	
A	----- WO 2011/095316 A1 (XEMC DARWIND BV [NL]; PASTEUNING JAN WILLEM NICOLAAS [NL]) 11 August 2011 (2011-08-11) * claims; figures *	1	
A	----- FR 2 401 868 A1 (BRETAGNE ATEL CHANTIERS [FR]) 30 March 1979 (1979-03-30) * figures *	1,12,13	
	-----	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			B63B
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		26 August 2020	Knoflachner, Nikolaus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 16 7326

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

26-08-2020

10

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102014000041 A1	09-07-2015	NONE	
EP 2151375 A1	10-02-2010	AT 532700 T EP 2151375 A1	15-11-2011 10-02-2010
WO 2011095316 A1	11-08-2011	EP 2531400 A1 WO 2011095316 A1	12-12-2012 11-08-2011
FR 2401868 A1	30-03-1979	FR 2401868 A1 GB 2006151 A US 4324385 A	30-03-1979 02-05-1979 13-04-1982

15

20

25

30

35

40

45

50

55

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82